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Understanding fashion complexity through a systemic data approach

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ABSTRACT

The role currently played by the fashion industry in contributing to the degradation of natural systems is increasingly being acknowledged. Acting, in terms of information flows, from a systemic perspective, not only represents a parametric adjustment, but also a reinforcement and a weakening of an existing cycle. This involves the generation of a new cycle, that is, of information, in a place where it was not previously present, and therefore induces different behaviour in people. The structure of information flows can act as an effective leverage in the fashion system if the information is delivered to where it was not available before, collected where it does not and used strategically to generate a change in people's behaviour. In the fashion system, where the information that circulates is sometimes unable to represent an ethical and social value, adding or restoring information can be seen as an important intervention, which is usually easier and less expensive than the reconstruction of physical assets.
The aim of this paper has been to offer a perspective that deals with this complexity and aligns fashion with sustainability values through insights gained from data.

Keywords: Data, Information Flow, Sustainable Fashion, Systemic Design

INTRODUCTION

Nowadays, the role played by the fashion industry in contributing to the degradation of natural systems is increasingly being acknowledged. The impacts on the environment are mainly linked to the use of non-renewable raw materials, water pollution and the generation of waste. In addition to these socio-cultural implications, as a result of the 'fast' fashion business model, the use of cheap labour and undignified working conditions, deliver standardised fashion at high volumes and low prices. Moreover, a significant lack of information and communication between stakeholders makes the interpolations of the system difficult to untie. In this context, therefore characterized by complexity, intricate interdependencies and flux, and a wide span, geographically, epistemologically and in term of disciplines and discourses it draws together since was first introduced to the realm of fashion (Fletcher, 2008) system and design thinking, has provided a helpful viewpoint on the area. In the fashion system, the approach that is generally adopted is a commercial one,

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based on the market, which prefers the systematic and frantic search for quick solutions to meet the needs of profit rather than those of consumers and the environment. The designer, within such a context, who applies this approach has limited time to think or reflect on the possible consequences of the project-process, as far as the environment is concerned, to solve the problems of design. As a result, the speed-to-market phenomenon causes designers to ignore detailed environmental knowledge, i.e. ethical resources, and requires others, who may not necessarily be design experts, to solve ecological problems in the fashion design process. What is missing is not so much a lack of knowledge of the problems related to sustainability in the fashion industry, which is a rapidly expanding concept, but a real collaboration, where each actor is able to address a specific problem without forgetting that the effects and causes are linked. For this reason, not only should strategies be concatenated, but also and above all, so should the information circulating within the system.

A preliminary literature review in fact revealed that acting, in terms of information flows from a systemic perspective, does not represent a parametric adjustment, a reinforcement or a weakening of a current cycle. It instead represents the generation of a new cycle, that is, of information, in a place where it was not previously available, and which therefore induces a different kind of behaviour in people. According to Meadows (1999), the structure of information flows can be a useful leverage point in the fashion system, if the information is delivered where it was not available before, thus causing people to change their behaviour. Adding to or restoring information in a fashion system, where the circulating information is sometimes not linked to any ethical or social value, can therefore represent a powerful intervention, which is usually more accessible and cheaper than reconstructing physical infrastructures. The aim of this paper has been to offer a perspective that can deal with this complexity and align fashion with sustainability values through insights gained from data.

1. FASHION AS A COMPLEX SYSTEM

Fashion is a powerful cultural lever, which is capable of influencing the consumerist economic model based on mass production that is currently in force. The fashion system is composed of interconnected elements that produce their pattern of behaviour over time. In her latest book, published for the first time in Italian in 2019, Fletcher not only defined the fashion system as a system that is rich in complexity, but she also associated the adjectives “stratified”, “multidimensional” and “multidisciplinary” to such a system. The papers we analysed during the research in the literature review phase highlight the coexistence and the indissoluble integrity of four areas in which fashion and sustainability are talked about - the technical, the political, the aesthetic and, finally, the psychological and behavioural areas. It is

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in fact impossible to consider sustainability without bearing in mind the technical problems related to the traceability of the production chain; the efficient use of energy sources, water and chemicals; the safety of the working environment; innovation in the choice and production of materials, the improvement of recycling practices; the use of a fair wage system related to the future impact that the fourth industrial revolution will have on automated production processes. Similarly, sustainability issues should include solutions that take into account national or international institutional policies or those that affect the business choices of individual brands. Fashion implies, and is conditioned by, systems of control and power at the highest levels of modern society and which, in turn, frame a system where the free choices of citizens sometimes do not change the games of well-known names. Addressing any phenomenon related to fashion in a correct way can no longer ignore the challenges of sustainability that the aesthetic variable brings with it: the fashion industry, more than any other, has perfected the cycle of invention, acceptance and rejection of a series, aligned itself with the ever-changing but constant ways of exhibiting its image, and almost surely released a cycle of change that was inspired by physical necessity through a series of variations that are only dictated by the aesthetic function.

The consumer behaviour point of view within the fashion system makes the system even more complex. From the outside, it is possible to say that the fashion system is fickle and superficial. However, in-depth knowledge leads us to admit that, within the global textile and clothing market, there are several stocks and flows, even in the aesthetics of clothing shapes. Our wardrobe is a complex system with some garments that play a fixed role, and others that play a variable role and which may flow more quickly. Garments such as trousers or jeans, t-shirts or shirts can be considered as standard forms, against which the consumer makes, or at least should make considered choices. However, the variability of lifestyles, culture and the relationships between the fashion system and territorial variables has resulted in some garments having different shapes and attributes, such as in height and circumference. In this context, where consumers are often in a position to choose which clothes to buy, the problem of design obsolescence triggers a whole series of issues not only related to the design process, but also to the loss of garments at the end of their life cycle. In addition to the variability in shape, there is also variability in the system due to the materials and their functional qualities. The ability of garments to withstand wear and tear and to maintain their properties of providing heat, protection and coverage, etc., contribute to this variability and are key aspects for a prolonged use and more sustainable behaviour. Considering fashion in these terms means thinking about the sustainability of production in the clothing industry as a process that involves structural problems in an interconnected way, such as the search for

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strategies to contain excesses and mitigate obsolescence, and behavioural issues, such as the choices made by the consumer about his/her garments.

Looking at the fashion system as a complex system also means being able to direct the outcome effectiveness of a series of changes and approaches in a broader perspective that makes the designer ready to predict and prevent objectives, time frames and scales of application. Each of these areas, like each and every complex system, is therefore regulated by strict rules and/or flexible interdependencies with direct or indirect repercussions on the consumers and ecosystems, from the smallest scale to the largest one. In the same way, a sustainable fashion system that is as complex as the non-sustainable one remains an interconnected flexible process that does not stop taking into consideration any of the four areas, thereby giving it such a process equal weight and importance when undertaking strategies aimed at change.

2. DATA AS A STRATEGIC TOOL FOR SUSTAINABILITY

The intersection of fashion system and new technologies is a vigorous and widespread space that simultaneously captures the intangible aspects of being human and fashion experience. The aim of this contribution, through the use of data with a holistic point of view, is not just about describing how businesses and brands include Big Data in their daily practices, but to help every stakeholder to add this resource to their toolkits to increase sustainable policies. Therefore, the fashion system is a complex system made up of different components and actors that interact with each other in several possible ways, and its overall behaviour is not obtained from the pure definition of behaviour, but from the objectives of individuals and their interactions. The ability to understand such a system in order to lead it towards a more sustainable fashion system is not limited to strategies oriented towards the knowledge of the individual parts, but above all to the ability to recognise and structure a vision of sustainability that is able to relate the various long-term procedures The Systemic Design (SD) approach, which was defined and has been tested in different fields of design, such as the food supply chains, focuses on the design of relationships between people, activities and contextual characteristics to improve the knowledge of complex systems. The use of data together with a systemic approach is aimed at generating a unified understanding of sustainability strategies of a system and at disseminating all the information that can produce a significant change which may influence the behaviour of the system. Moreover, using data aimed at holistic relief can guide a designer towards obtaining a deep understanding of the issue, and outlining the real roles of all the actors involved in their fields of application, their development and their relationships in their operational context.

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Data, fashion and sustainability, within a broader discourse, are part of the potential already mentioned above, that is, transparency and traceability of the supply chain, in-depth knowledge of territorial dynamics and last but not least, the creation of a direct relationship between the company and consumers based on real needs rather than on-trend forecasting guided by consumerism and profit. Data represent a quantitative input that, when analysed, understood and used from a systemic perspective, produces a qualitative output of high value, in terms of awareness for companies and consumers. At the end of a preliminary literature review on the sustainability strategies already in existence in the fashion world, merged with a new technological field, the concept of Leverage Points, which was developed by the scientist and system-thinker Donella Meadows, was used to identify the places where to intervene in the industrial scenario, and in society in general, to create a change of system.

3. A SYSTEMIC INNOVATION DESIGN METHODOLOGY APPLIED TO FASHION DATA

By using SD as a catalyst of change, this research looks at data generated holistically inside fashion system, and defines all the processes, services and actors as a dynamic whole and not as a fragmented sum of all the parts. Contrary to what happens with the sustainability strategies currently in use, which are focused on symptoms and endorse methods that try to solve single problems without caring about existing relationships, the SD approach can be a useful tool to restore the lack of information concerning the whole process and all the actors. The complexity of the fashion system and the framework of environmentally sustainable fashion design means that designers ignore the required technical knowledge, i.e. ethical resources, and require others, which are not necessarily design experts, to solve technical problems in the design process (Smal, 2014). A potential result is that designers, in the development of sustainable fashion, wait for the government, legislation or consumer responses to dictate what needs to be changed regarding environmentally sustainable products instead of adopting a design-driven innovation process (Fletcher & Grose 2012:33). On the contrary, a multidirectional use of data along the entire supply chain allows sustainability to be implemented in the fashion system, starting from the role of designers. An SD approach, which looks at the larger picture, focuses on the transition from a linear vision, where individual environmental issues are addressed, to a systemic approach, where an improvement in the individual components, if correlated, corresponds to improvements for the whole industry. Moreover, through a systemic use of information, the fashion industry can act constructively to stimulate positive practices and quality development in order to attain sustainability in a similar way to the food sector. In this sector, working on the flow of information, and, for example, promoting organic labelling schemes, or informing

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consumers about the poor quality of products from fast-food chains has led to a change in consumer behaviour as a result of promoting a healthier lifestyle. Data can be involved in an innovative approach in the fashion creation phases and at the same time, can implement processes and applications in a more sustainable way.

3.1. Methodology

Complex systems are inherently unpredictable, because it is impossible to explain a high percentage of variance that affects results. Under these circumstances, minor disturbances in one part of a system can be amplified to produce larger effects somewhere else. Moreover, this is what happens in the fashion system: the purchase of a garment in a highly fragmented chain, with high social impact, can have devastating consequences on the environment and the entire system. The multitude of social and economic activities that are understood and constitute the fashion system is therefore from necessity complex.

In order to navigate the complexity of such a strongly interconnected system and which is based on an apparent win-win model that hides its real inability to be transparent and communicative, it is necessary to apply an information flow strategy, based on data and all of the technological tools which could reveal information.

The research, starting from the analysis and the recognition of fashion as a complex system, is aimed at identifying the relationship between components and different elements. By integrating data, it becomes possible to inspect and clearly understand not only the business and organisational needs, but also the human and behaviour patterns of choice, use and consumption of a fashion product. This is because working with data means producing knowledge.

The literature review phase pertaining to the fashion system and the customers journey map analysis phase have shown that some basic knowledge of the sustainability process is missing. Companies do not collect enough data from the consumers regarding the purchasing processes, and the consumers do not have detailed knowledge about the sustainability issues that affect clothing in order to help them make appropriate choices. The data-driven research approach applied to the fashion industry goes beyond the collection of empirical sales data, and provides companies and designers with specific research, processing and analysis tools of their products in relation to their consumers and plans to do so in relation to the context of use. It is therefore necessary to pay attention to the type of questions that the company will have to ask itself related to the collection, analysis and use of data, so that they are a prerogative for a more sustainable design.

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From an operational point of view, the research is based on the intention to highlight the capacity of interconnecting people, processes and environment with fashion: we apply the Systemic Innovation Design Methodology (Gaiardo, Tamborrini, 2017) to enhance knowledge and understanding about the system, to produce functions, objects and processes for the wellbeing of both the individual and society as a whole. With this methodology, it is possible to combine system thinking skills with design thinking in order to address fashion system complexity, and a collection of data becomes useful to generate new awareness and identify patterns of behaviour.

This methodological design process includes a preliminary phase, in which the project and the user are defined, with the description of the topic and the boundaries of the action in context through the use of a data-driven strategy. This is followed by a meta-design phase, i.e. the design expectations provide indications and guidelines without arriving at defined solutions for the realisation of the project, and an iterative process follows where the research and design phases are combined. The designer's task is to ask himself/herself the right questions, as suggested by the context, and to answer the questions about why he/she is adopting a particular solution, what the best solution is and how the chosen solution works for the user and in the context. This iterative process, and the use of a data-driven strategy, are the critical points for the choice of this methodology during the research. Data are no longer considered a static asset whose use ends when the purpose for which they were collected has been accomplished; hence, they can now be considered a raw material, and a vital input, used to create new forms of value as well as sources of innovation and new services (Gaiardo, Tamborrini, 2015).

This kind of study starts with a holistic analysis of the current situation, in which all the life cycle steps of garment production and all the actors and the actions undertaken or undergone by the context in question are clearly outlined.

Since fashion is more than just the materials that garments are made up of, the availability of data offers gives us the opportunity to go beyond the lack of information that concerns the whole process and all the involved actors.

A technology-enabled sustainable fashion system operates in a similar way to an ecosystem, in which there is a conscious evaluation of the impact and of both inputs and outputs, of how they depend upon and influence one another, and of the environment as well as the economic cost of each decision. The aim of this research is to give a sort of structure to a large number of collected data, which is capable of capturing the context underlying

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connection, drive insight through design and organisation and last but not less critical create value identifying and defining sustainable strategies.

3.2. Stages of The research

The need for a systemic change, dictated by the environmental crisis, means that different choices will be made by consumers and companies, related not only to material supplies but also to the habits in our lives and the way we express ourselves through fashion.
For this reason, a series of structured activities that manage the collaborative and participatory processes that are developed over the data is necessary.

The preliminary phases of the research, that is, before the information was collected, are illustrated hereafter; nevertheless, the following subsequent stages, which are expected to be developed in the future, according to the systemic innovation design methodology, are also listed for comprehension reasons.

3.2.1. Mapping the current fashion system to identify the information gap

The first stages of the research involved mapping and analysing each step of the customer's journey, in order to find any information gaps and select data from the context-rich, real-time and in situ pool of data that will be collected in the subsequent steps. This preliminary focus on the customer's experience, from the customer's perspective, right from the start, is aimed at understanding a customer's behaviour, feelings, motivations and attitudes before, during and after a shopping experience. The customer's journey includes all the activities and events, the emotional and physical journey and all the activities between the customer and his/her garments in order to examine the relationship in between.

This step is essential to identify the other involved actors, the nature of their relationship, as well as the knowledge and the technologies that are available and which could be useful in the subsequent collection and analysis phases.

The analysis of the customer's journey map, which was conducted during the early stages of the research, shows how companies do not have enough consumer information in the first phase, that is, of identifying needs: are they buying for a real need? Are they buying to replace something that has worn out? Or are they buying to obtain pleasure? Who are the real influencers of their purchasing choices?

Another large gap is the information pertaining to the dressing room: what is wrong with a garment that has not been sold?

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And finally, companies, but also designers, lack a mapping on the use, and on the established relationship between a user and a garment and its actual life span.

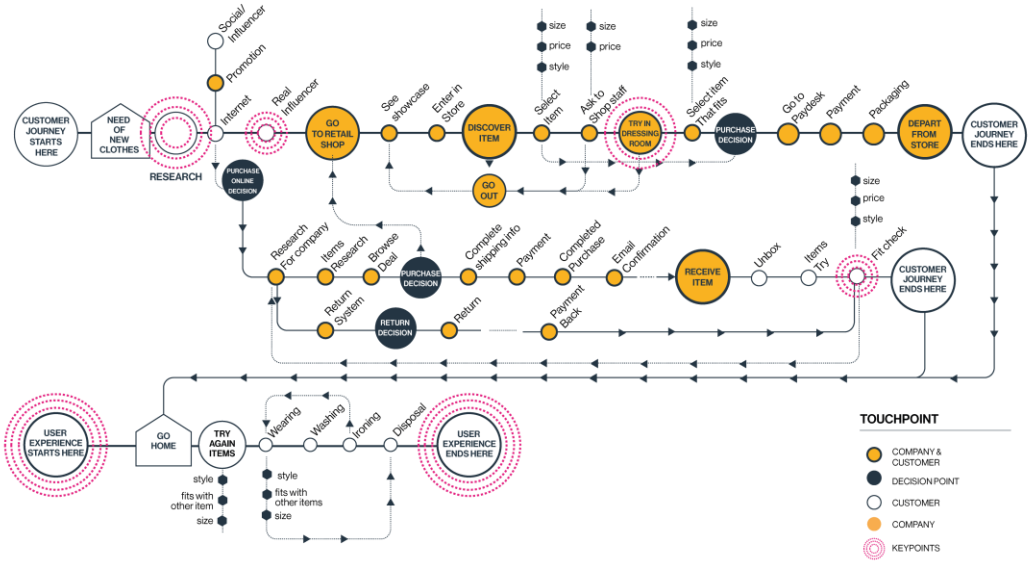

Figure 1. Customer's journey map – identifying the information gap

3.2.2. Planning the data collection

The result of the first step is the clear overall picture of the system from the customers' point of view: it is therefore crucial to structure the data collection in detail. The transformation from data into useful information at all levels of the design process requires a continuous process in which data are collected, classified and appropriately contextualised in a specific analysis context. The structuring of the collectable dataset involves the evaluation of qualitative and quantitative data that will be integrated in the research in order to understand as many aspects as possible. In this phase, three datasets were identified:

1. customer information;
2. product information;
3. information flows.

All the data associated with a fashion product are called fashion data. These data are already used by companies to conduct trend analyses, for forecasting purposes, etc., but in reality, they do not concern the use phase. For this reason, they do not allow a real connection between company-product-consumer as a unicum. The fashion industry generates and

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creates various data sources. All these data are available in multiple forms, such as in words, pictures, etc. Since it is the fast fashion era, data are overgrowing and changing rapidly. Therefore, these data can be defined as "big fashion data", as they portray all the characteristics of big data.

The nature of the customer-based data set is not intended to draft the consumers' needs to produce perfect deals for companies, which would have nothing to do with sustainability goals, but instead have the final objective of generating an even closer relationship between consumer and product in order to lengthen its life cycle. For this reason, a part of information research is aimed at obtaining data related to a product. A recent report, edited by the Fashion Revolution movement, has in fact dealt with understanding what information customers would like to have or should receive from manufacturers about the environmental impact of their products and what kind of information influences the purchasing of certain products. The results of the survey conducted by the Fashion Revolution Network revealed that consumers would like to receive more information about the origin of the used raw materials, the impact on the environment and workers' rights, and not least the social and environmental conditions of their entire supply chain. The screenshot of the prototype app, which is presented later on in the text, shows how not only the supply chain data that the consumer already knows they need may be visualised, but also how data about the impact of their choices that could change their behaviour can be seen. Examples of similar strategies are available in other fields, such as in the energy sector, where the visualisation of consumption data on bills has been shown to change habits, or where a whole series of views about personal activity data have been shown to affect the users' lifestyles. Moreover, there is a lack of clear information on the sustainability impacts of the supply chain, and it is difficult, for the consumer, to compare for example to the food sector of which he has acquired knowledge over time.

The search for information on the product dataset is structured with the same objectives. Future research could concern the development of the following steps:

1. Collection of information;
2. Information analysis;
3. Validation of information;
4. Detailed guidelines;

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5. Definition of concept;

6. Experimentation and project development.

4. RESEARCH OUTCOMES

The content of this research returns four levels of results that complement each other and help to solve, in a complex way, the criticalities previously highlighted in the fashion system.

1. The **Research-level,** which refers to consumer behaviour, consumption as an everyday practice, unconventional user behaviour, systems of use, measuring sustainable consumption and mapping ecological footprints etc…;

2. **Service-level,** which refers to both companies and consumers, with the aim of developing strategies to increase consumer awareness and the sustainable impact of companies;

3. **Product-level,** which refers to the enhancement of product sustainability;

4. **Organisational-level,** which refers to redefining the process and spreading transparency and circular economy policies.

In short, Big Data has the potentiality of unlocking exciting areas in the fashion industry for design disciplines, such as that of consumer behavioural data or unconventional use behaviour, which are capable of generating value within the system but also of making the intrinsic value visible, thereby becoming a fertile territory for the most suitable innovative intervention (the best decision). Big Data will contribute to the optimisation of the supply chain and the development of sustainable products and services, but is essential to point out how it is possible to generate a unitary and coherent understanding of the whole system that would also allow a sustainable development in all the systems connected to the fashion world.

The combination of quantitative and qualitative data helps those involved in the system to understand where they should focus and how to provide meaningful insights to ensure that the weakness is balanced by another.

The following figure is an example of a case study on how having access to personal information can vary the level of awareness of sustainability in choices related to clothing.

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Figure 2. screenshot of an app prototype

In the first screen, each circle corresponds to a category of clothing: the size of the individual circles communicates the amount of clothing owned by a person for a given category.

The second screen displays the number of garments used in the wardrobe: each circle corresponds to a single garment. The size of a single circle indicates the number of times the garment has been worn. Crossed-out circles identify garments owned but not used because of the temperature. In the third screen, it is possible to obtain the set of combinations that the user generally chooses to wear, by clicking on a particular circle. The colour of each circle identifies the category of garments. The proximity of the circles identifies possible

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combinations; the distance of some circles highlights isolated combinations: disintegration of the garments inside the wardrobe is an indication of weak sustainability.

The three final screens highlight the overall impact (production and use) of the wardrobe. The impact is given for the number of garments owned and their life cycles. A small number of combinations within the wardrobe indicates weak sustainability.

5. STUDY LIMITATIONS AND SUGGESTIONS

In conclusion, the article is related to big data, system thinking and data visualization, but some limitations need to be mentioned.

The existing literature that links data analysis and system thinking undoubtedly requires further development.

Therefore, an approach, such as the one adopted in this research, would improve all those technologically advanced systems that support prototyping, and which are not yet widely developed.

For example, the collection of data on the use of fashion products still does not have an interconnected system, and this could be a weak link in the research. Studies and experiments could be conducted to map the logistics of garments, and it could also be possible to monitor the washing cycles of some textile products in industrial laundries. Several attempts have been made to create intelligent dressing rooms and wardrobes that are able to expand and improve the users' experience. However, there is no evidence that all these systems can be connected to each other or transferred to companies and users as a continuous unicum of data.

The research does not envisage that the collection of data is solely delegated to the end-user but aims to relate the system actors and evaluate the development of new tools capable of putting information into the system.

Finally, a further limitation is represented by the lack of collaboration between the actors of the system to implement sustainability strategies.

The objective that this research is to reach and suggest that a change in tools, and therefore the integration of big data, can change the whole theory of sustainability in the fashion system - just as in the industrial revolution, when Henry Ford changed the world in which cars had been built, by transforming the work itself and introducing a new production system, new products and the concept of standardisation.

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In the same way, big data can help create a new knowledge system, to assist society in the understanding of the future and the problems related to sustainability.

What generally emerges from all the research is that focusing primarily on technical aspects rather than on the fallout from them is not enough. There is a need to shift the focus to the creation and reformulation of new organisational structures, using big data to change the very nature of the approach to sustainability, by reshaping products, experiences, activities and professions. Technological challenges are incredibly complex and are often based on long response times; for these reasons, the path must from necessity fit into a broader strategy and vision that takes into account skills and context.

Therefore, given the still widespread mistrust in technology investment and more generally in the combination of technology and sustainability for change, large companies and small realities should intervene through a collaborative approach, in which the places of innovation are intercepted, starting from the needs of the user and the context. Only in this way will it be possible to strategically think of new innovative, scalable, replicable business model strategies that can act as a lever to accompany change.

6. CONCLUSION

The proposed strategy, which uses data on the fashion system to stimulate a sustainability strategy, is based on two elements: an intelligent organization of activities, and a modular structure that allows the system itself to act in an interconnected way, thereby allowing the various implemented actions to be combined. Finally, a data-based strategy would not work without those who have to read the data having the ability to do so.

Forecasting consumer demand for fashion is a complex issue. Big Data can help to predict customer behaviour in order to steer the fashion industry in the right direction. However, having access to many data is not enough for a system, such as that of the fashion world, to be more efficient in dealing with the reality of biophysical limits and their incompatibility with the logic of growth.

It is therefore planned to organise the results of the research in four stages.
The first phase will consist of an evaluation of the fashion system as a complex system through a literature review divided into three macro areas: sustainability strategies in fashion, sustainability strategies using data, and product development strategies based on data. The literature review and the customer journey map provided the authors with a solid understanding of the current state. They highlighted where information is lacking or missing,

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and pointed out that that all the information that refers to the end of life of a product and the phase of use by the consumer is missing. Phase two will therefore include an analysis of the Leverage Points and the identification of the potential barriers and gaps that prevent the success of the Leverage Point related to information flow strategies. The study of the Leverage Points has allowed the entire literature on sustainability strategies to be filtered. Moreover, in this phase, the collection of information from the user and an extension of the research through the involvement of experts in the field of big data and sustainability within fashion companies, who have the task of providing valuable information on several specific thematic areas, are foreseen.

Phase three will determine strategic guidelines for the involved actors through systemic innovation design methodologies. Using the results of the first two phases of the research, the authors will develop strategic guidelines for companies pertaining to the design of products and services with the ultimate objective of user involvement and sustainability of the system. Phase four will foresee the development of a service product prototype that will be introduced into the research area as a possible extension of one of the guidelines developed in phase three. The validation of the results is foreseen for the end of the PhD work of one of the authors, with the aim of generating and co-creating the methodological principles of the development of sustainable products and services for the fashion system in batches of data use.

The aim of this research is to underline the importance of collecting interaction and relationships in a significant dataset. SD could represent an approach that enables a holistic view of the whole fashion system, thereby allowing a complete elaboration of the complexity of the users' behavior and of that of the upstream processes, while bearing in mind the centricity of the involved individuals and the context within which sustainable projects can be developed; a comprehensive view of the entire fashion system could thus be generated. Innovation and change, combined with the enormous potential of data, can start, as we have demonstrated, from any different stage of the supply chain and can produce significant results for the environmental responsibility of fashion companies.

Future research will concentrate on the collection of data and holistic relief, starting from a company and supplier perspective.

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